

MUSINGS ON THE EVOLUTION OF A COSMOS

A particular kind of string theory in ten dimension (called type II B string theory) can be compactified with five of the dimensions wrapped up as 5-sphere (S^5) and the other five dimensions taken to describe a 5-dimensional anti de Sitter spacetime with negative cosmological constant (AdS_5). The whole manifold will then be $S^5 \times AdS_5$ with the metric on the AdS sector given by

$$ds^2 = dr^2 + e^{2r} (\eta_{\mu\nu} dx^\mu dx^\nu) \quad \mu, \nu = 1, 2, 3, 4.$$

This string theory has an exact equivalence with the 4-dimensional $N = 4$ supersymmetric Yang-Mills theory. It is known that the latter theory is conformally invariant; the large symmetry group of the AdS_5 matches precisely with the invariance group of Yang-Mills theory. The limit $r \rightarrow \infty$ is considered to be the boundary of AdS space on which the dual field theory is defined.

If gravity behaves as a local field theory, then the entropy in a compact region of volume R^3 will scale as $S \propto R^3$ while indications from the physics of the horizons is that it should scale as $S \propto R^2$.

The AdS spacetime has a negative cosmological constant while the standard de Sitter space-time has a positive cosmological constant. Generally, there are few solutions to string theory which contains de Sitter spacetime or even any solution to standard Einstein's equation with a positive cosmological constant.

The existence of a state of lowest energy or ground state is crucial for the classical stability of a physical system. In gravity, positive mass theorems establish the existence of a unique, zero mass ground state in both the asymptotically flat and the asymptotically anti-de Sitter (AdS) classes of spacetimes.

The RS Model in general stipulates our vacuum state as a degenerate ground state of an original AdS spacetime trapped by certain mechanisms like the Israel condition. But little discussion exists on how our brane with its positive energy and trapping mechanism of the Israel condition came into being in the first place.

We could predict that scattering of particles across an AdS spacetime will at the limit

$$R \rightarrow \infty$$

approach a flat space-time approximation[1]. So in general the outer boundary of an inflating AdS spacetime will then approach more closer to a flat de Sitter spacetime. So is there anything we could learn about the evolution of this outer boundary?

In a thin wall approximation we can represent the boundary in 5d gravity by a delta function source with some coefficient $f(\Phi)$, where the Φ is a bulk scalar field, the dilation parametrizing the tension of the wall or brane. While it is true that quantum fluctuations of the fields should correct this function or modify it, we might well ask that since this relationship exists is it possible the fluctuations of fields originally not trapped within the domain wall, but existent within AdS spacetime actually brought about the creation of the particles and fields trapped on that domain wall? The reason for asking this question will become apparent shortly.

As long as we consider quantum corrections only which modify $f(\Phi)$ while maintaining the bulk 5d gravity action we find that none of the corrections or actually shifting of brane tensions will destabilize the flat spacetime condition[2]. In fact they generate a tree-level distribution of energy ranges not unlike the one we encounter under the Standard Model with particle masses. Going a bit further we discover there is little reason for fine tuning since the restraint of a finite 4d Plank scale restricts the sign of f and the value of F/f on the wall itself which forces the value of the Cosmological constant to be in the range of an order of 1.

From this we could easily derive a picture or model of our universe existing as a brane or domain wall on the boundary of AdS spacetime approaching a condition where $R \rightarrow \infty$ holds. It would follow then that our positive energy spacetime with all its Israel condition trapped fields and particles is simply the natural result of quantum fluctuations of fields within the AdS spacetime itself. If we should find that the trapped vacuum state has evolved with time then that evolution itself would be the result of quantum evolution of the AdS spacetime fields.

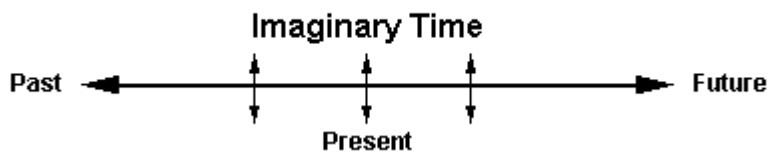
Looking backwards in time toward the original evolution of the AdS spacetime from the trapped perspective of the brane there would be little difference found from an observational point than that encountered in the normal Big Bang Model. We'd see a consistently flat spacetime evolving from what appears to us as a singular point getting larger and larger until regions become casually disconnected. We'd have certain aspects that seemed to defy observation of the source and perhaps hint at the presence of unseen particles and forces because of our being limited in observation to only those processes that transpire on the brane within the domain wall.

As such we would suspect that a certain unseen or exotic aspect of energy must exist and that we perhaps have matter that exists in our trapped universe that we cannot observe directly, but, only through certain actions its presence would seem to be generating. In short we'd end up with a universe that observationally appears much like our own.

THE QUESTION OF TIME

Feynman recognized that time as we think of it becomes imaginary in the time reference we standardly use, because this time is totally indistinguishable from directions in space. If the universe exists in an unseen way without beginning or end, at right angles to regular time, then that time is simply more elementary and even more real than ordinary clock time. Thus it seems the term imaginary applies more accurately to our time. If the universe exists in another time reference where conditions are permanent or static, suddenly it doesn't matter that we humans so convincingly observe a beginning and a possible future end to our ordinary clock time, since the other time reference applies regardless of our sense of where we are in time. The universe could be said to exist before our clock time began, and after time ends.

All moments share this time reference which has no beginning or end.



This is exactly what one would expect from the before mentioned evolutionary model. Our time would be but a subset of a greater time that for all intents might extend into the past and future unlimited.

REFERENCES

- [1] Joseph Polchinski, S-Matrices from AdS spacetime
- [2] Shamit Kachru, Michael Schulz, and Eva Silverstein, Self-Tuning Flat Domain Walls in 5d Gravity and String Theory
<http://www.slac.stanford.edu/pubs/slacpubs/8250/slac-pub-8337.pdf>